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Biogeosciences Discussions

Interactive comment on "Dissolved and particulate reactive nitrogen in the Elbe River/NW Europe: a 2-year N-isotope study" *by* T. Schlarbaum et al.

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First of all thank you very much to the referees for reading the manuscript and for their constructive and helpful comments.

Both referees are in agreement that we have an interesting set of data about the reactive nitrogen pool in the Elbe River, but both are of the opinion that our discussion to interpret the data is often too superficial and hypothetic. To take all the helpful comments into account, a complete revision of the discussion part will be necessary, but this will probably go beyond the scope of this interactive discussion. We will carefully consider the arguments of the referees when we get the opportunity for a revision of our manuscript.

In the following we will try to respond the single comments the referees pointed out.

Referee #1:

“The authors note the revision of the nitrate standard composition in 2.3.1. It might be useful for readers to know if they need to convert to the new standard if this is a simple linear change or if it is more complicated.”

To convert the δ15N-NO3- data to the new standard, a more or less linear change can be made. For a rough calculation add 2.8$\pm$0.1‰ to the data presented in the script. In the range of the observed values, this is an adequate calculation. We will add this in our manuscript.

“In Table 2 average values for nitrate and DON concentration and isotope composition are presented. I note that the environmental variability of nitrate isotopic composition is about 20 times the analytical variability, but the equivalent environmental variability of the isotopic composition of DON is similar to the analytical variability. If this is correct it does emphasise that the DON variability the authors discuss is very close to the analytical limits of the method.”

It is true, that the analytical limits of the method to determine δ15DON+NH4+ are quit high, especially compared to the method to determine nitrate isotopes. However, the observed range of δ15DON+NH4+ values between 0.8‰ and 11.5‰ is about ten times the analytical variability. We are of the opinion that our data are accurate enough to reflect the seasonal trends in the Elbe River, since the differences between the minima in spring and autumn and the maxima in summer and winter are clearly to observe.

“P7554 line 8 I suspect light rather than temperatures drives the seasonality.”

We agree that the seasonality is rather due to sunlight than due to temperature and we will correct this.

“I would suggest that the authors clarify that they are assuming no fractionation in sedimentary denitrification. I agree with them that water column denitrification is unlikely,

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but denitrification within agricultural fields as well as within the body of the river is probably important."

To our knowledge fractionation in sedimentary denitrification can be neglected, since the rate limiting step is the non-discriminating process of nitrate diffusion with a low isotope effect near to zero as described by Deek et al. . (Seasonal variations in nitrate isotope composition of three rivers draining into the North Sea, Biogeosciences Discuss., 7, 6051-6088, 2010, doi:10.5194/bgd-7-6051-2010), Sigman et al. (Distinguishing between water column and sedimentary denitrification in the Santa Barbara Basin using the stable isotopes of nitrate, Geochem. Geophys. Geosyst. 4(5), 1040, doi:10.1029/2002GC000384, 2003) and Brandes and Devol (A global marine fixed nitrogen isotopic budget: implications for Holocene nitrogen cycling, Global Biogeochem Cycles 16(4), 1120, doi: 10.1029/2001GB001856, 2002). We will add this to our manuscript.

"P7555 I agree entirely that the PN will have mixed sources, but I would query the interpretation around line 21 that changes in PN reflect changes in resuspension with flow as well as consumption. Firstly the resuspended PN is likely to have rather limited bioavailabilty. The correlation of DON and PN isotopic signal may indeed reflect processes such as the authors describe, but could also be a coincidence, or reflect the significant analytical uncertainties in both values, or could reflect both DON and PN responding to similar physical driver such as increased flow and resuspension."

We agree to these arguments and will revise this passage.

"Section 4.3.1. As noted from the various references, the bioavailability fraction of DON is generally rather low, so it seems hard to create a significant seasonality in its cycling, particularly when the concentrations of readily bioavailable nitrate and ammonium are quite high."

For phytoplankton and microorganisms it is often more convenient to use nitrogen sources which contain nitrogen of the same (reduced) oxidation state that is needed,

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so we think that the LMW DON and ammonium is taken up, even if nitrate concentrations are quite high. But we agree that also other reasons for the decrease may exist, like the decrease of river discharge, so we will rewrite this passage.

"4.3.2. My understanding is that nitrogen loss from fields in summer is often rather small because of high crop requirement and low water loss, so I wonder if inputs from agriculture really can drive much of a seasonality."

We think that agriculture inputs can drive much of a seasonality since organic fertilizers like slurry and liquid manure were spread widely and not selective like synthetic mineral fertilizers.

"I would also query the logic of the argument about summertime DON cycling which seems to require DON release under nutrient limitation (DOC certainly but perhaps not DON) and then rapid utilisation of this DON. In summer nitrate concentrations are low but not limiting for production. Phosphate may fall to low concentrations but that may not mean it is limiting since it can be rapidly cycled and DOP may also be available. In this sense I would suggest that rivers such as the Elbe differ from coastal waters where inorganic nutrient concentrations do fall to levels low enough to induce real nutrient limitation on algae."

The DOP concentration is also very low during spring and summer (max. 2.9 μM). However, we will reconsider our argumentation and will take also other aspects into account.

"4.3.3. I would suggest the authors clarify the mechanism they suggest for DON sedimentation, and I would note dilution is an alternative explanation."

We agree that we did not consider dilution due to higher river discharge and will add this to our argumentation. And we will go more into details about DON sedimentation.

"4.3.4. I do not know this catchment, but my understanding was that fertiliser use in autumn was restricted since the crops do not need it during the non-growing season."

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In the Elbe catchment in northern Germany the cultivation of winter wheat is very common. The chamber of agriculture in northern Germany informed us about this fact and also about the common use of organic fertilisers and manure up to the end of October, before the ban of the use of fertilisers comes to effect.

Interactive comment on Biogeosciences Discuss., 7, 7543, 2010.